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MODEL 86MM-1

USER'S GUIDE
One Motor
STEPPING MOTOR CONTROLLER/DRIVER

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Contents

INTRODUCTION

FEATURES

SETUP
- CAUTIONS, 4
- I/O, 5
- Turn ON, 5

FRONT PANEL INPUT
- JOG/SLEW MODE, 6
- DIGITIZING, 6
- MENU SELECTION, 7
- CLEAR button, 7

PROGRAMMING
- COMMANDS with VARIABLES
  - Settable, 7
    - 200 step/rev, 400 step/rev, 7
    - Backlash compensation, 7
  - Programmable, 8
    - Advance per step (table), 9
- IMMEDIATE COMMANDS, 10
- MEMORY/BATTERY RETENTION, 12
  - Bytes of memory for commands (table), 12
- EXAMPLES, 13
- PROGRAMMING FROM BASIC ON A IBM TYPE COMPUTER, 15
- LINKING CONTROLS, 16
- TROUBLESHOOTING PROCEDURE, 18

HARDWARE
- LIMIT SWITCHES, 20
- CABLES, 20
- BATTERIES, 20

SPECIFICATIONS
- FUNCTIONAL, 21
- MOTOR COMPATIBILITY, 21
- PHYSICAL, 21
- ELECTRICAL REQUIREMENTS, 21
- ENVIRONMENTAL, 21

INTRODUCTION

The 86MM is a programmable stepping motor control. The Control incorporates a one-chip microcomputer that has on-chip RAM and ROM. The RAM is available for storage of a user-entered program and motion parameters. Commands and data are entered either through the front panel keypad or over the RS-232C interface from any host computer, terminal, or programmable controller having an RS-232C port. Specialized Commands provide simple and efficient entry of complex, yet compact, programs. Short programs are automatically retained in the portion of RAM which is battery-backed.

FEATURES

A complete microcomputer-based Control with nonvolatile user memory and motor drive in one package.

Motor Resolution can be set to 200 or 400 steps per revolution.

JOG/SLEW mode allows motor to be jogged one step or slewed from 16 to 2850 steps/second from the front panel (joystick emulation).

A Digitizing function can be utilized with a host terminal connected as a readout of motor position.

Menu LEDs provide command-selection from the front panel.

Keypad with audible and tactile feedback provides data-entry at the front panel.

RS-232C Port connected to a host allows Command and Data entry, Polling for status, and Absolute Position. Up to 255 controls can be operated from the same RS-232 port.

Acceleration/Deceleration settable from 8000 to 56000 steps/sec^2 in 8000 step/sec^2 increments.

Speed settable from 16 to 3000 steps/sec in 1 step/sec increments.

Incremental Index distance is programmable from $\pm$1 to $\pm$1,048,575 steps.

Programmable Return-to-Zero position.

Loop Commands provide from one to continuous repeat operations.

Programmable Pauses from 100 milliseconds to 13.65 minutes.

A User Output can be programed to turn ON and OFF an external solid state or reed relay.

A User Input can be utilized in a program as a WAIT for external switch or relay closure.

Backlash Compensation can be set to automatically finish every index approaching from the positive direction.

Run, Reset, Output, Input, and RS-232C connections are accessible at a removable terminal block on the front panel.

Limit Switches for CW and CCW directions are provided with plug-in connection to UniSlide "J" assemblies. Limits can be used for "homing."

Automatic Power Down reduces power consumption by de-energizing the motor when at a standstill.

Single Step mode is provided for debugging programs or as a controlled interrupt.

The Control can be polled for its status at any time; additionally a ready prompt (">") is automatically sent to the host when a program has finished.

Capable of running large motors, up to 10 amps total (5 amps/phase).

Twelve month Limited Warranty.

SETUP

*** * CAUTION * ***

* HAZARDOUS VOLTAGE, DO NOT REMOVE CONTROL PANELS OR COVER
* DO NOT CONNECT OR DISCONNECT MOTOR WHEN POWER IS "ON"
* HIGH TEMPERATURE, CONTROL SHOULD BE KEPT AT LEAST 6 INCHES FROM ANY OBJECTS
* AIR MUST CIRCULATE THROUGH AND AROUND CONTROL, DO NOT BLOCK AIR VENT IN BOTTOM OF CONTROL
* NEVER USE IN AN EXPLOSIVE ENVIRONMENT
* IN INDUSTRIAL ENVIRONMENTS, THE CONTROL MUST BE PROTECTED TO PREVENT METAL CHIPS FROM FALLING INTO IT
* SEVERE ELECTRICAL DAMAGE MAY RESULT IF OBJECTS FALL INTO THE CONTROLS HEAT SINK

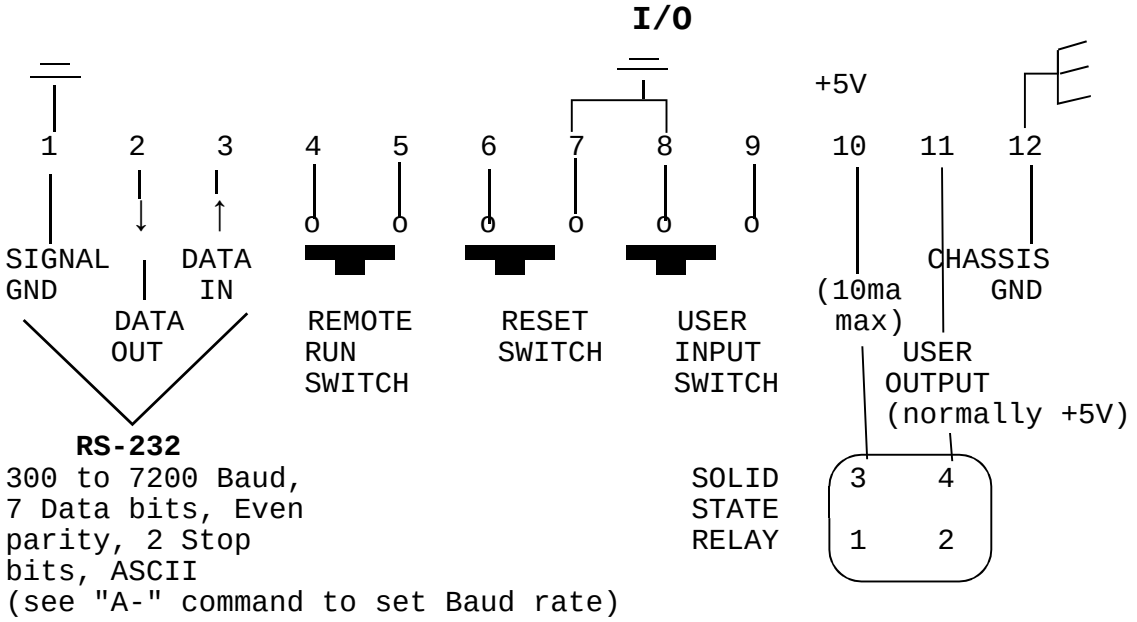
1. Connect cables to motor and limit switches.

CAUTION: Never connect or disconnect motor with power ON, this may result in severe damage to motor drives.

2. Plug Control into 120VAC outlet.

Input/Output (**I/O**) connections other than motor, AC power, and limit switches are located at a removable terminal block on the front panel.

PIN #	DESCRIPTION	PURPOSE
1,2,3,12	RS-232C Interface (Signal Gnd, Tx, Rx, Chassis Gnd). 300 to 7200 Baud, 7 Data bits, Even parity, 2 Stop bits, ASCII	Allows constant program and parameter changes from a computer or P.C. Provides visual feed-back when attached to a terminal.
4,5	Remote Run	Allows program-Run from an external switch or relay.
6,7	Reset	Can be used as a emergency stop, or to synchronize the Control with other equipment.
8,9	User Input	Used as a "Go" signal from external equipment. Pin 9 is internally held "HIGH" by 1K ohm resistor connected to +5V.
10,11	User Output	Signals or actuates external equipment between moves. Capable of powering a Solid State or Reed Relay.



3. Turn ON the Control by pushing the POWER switch to the right. The JOG/SLEW light will come ON.

NOTE: Data in memory is retained when the Control is "OFF" by rechargeable batteries within the Control, that are charged when the Control is "ON". A loss of data retention due to low battery voltage is indicated by a flashing of the LEDs and beeping for 2 seconds after turn-on. This may be the situation with a new Control that has not been operated long enough to fully charge the batteries, or if four or more weeks of non-use have elapsed. See the section on MEMORY/BATTERY RETENTION for more information.

FRONT PANEL INPUT

JOG/SLEW MODE: * **JOG/SLEW**

1. With the Control in the JOG/SLEW mode, the motor can be jogged one step, or slewed from 16 to the last STEPS/SEC value (SLEW will not exceed 2850 steps/sec) in either direction.

2. To JOG the motor positive, press the "1" key momentarily; the motor will move one step CW. To JOG negative hold the "-" key down and press the "1" key.

3. To SLEW the motor, hold down the "1" key, the motor will run at 16 steps/sec. To increase speed press the " | " key until the desired speed is reached. Release the "1" key to decrease speed. The motor accelerates and decelerates at 8000 steps/sec^2.

DIGITIZING

The 86MM stores its absolute position (relative to the position when power was applied or when registers were zeroed) in memory until the Control is turned-off. The absolute register reflect the accumulated distance from operating the motor in the JOG/SLEW mode and/or under program control. This register can hold from -8388608 to +8388608 steps.

With a host terminal or computer connected via the RS-232C interface, the Control can be used as a digitizer. In the JOG/SLEW mode the 86MM will send motor position to the host when it receives a "D". Here is an example of what the host would receive when motor is at absolute 201:

+0000201

This is what the host will receive if the motor is at negative 1294010:

-1294010

A linefeed and carriage return follows the above values.
The host can "zero" the registers by sending a "Z" to the Control.

MENU SELECTION

The " | " and " | " keys are used to make selections on the front panel menu.
Pressing keys other than the "RUN", " | " or " | " results in an audible feed-back from a buzzer within the 86MM.

Refer to the next section on COMMANDS with VARIABLES for proper values to enter.

If the Control contained a program the last time the POWER was turned OFF, the Control will prevent any menu selection past ACCEL/DECEL. This feature limits editing to baud rate and acceleration/deceleration.
To "CLEAR" a program from memory press the recessed **CLEAR button** on the front panel using a pen or pencil.

Simple Example

Below is an example that will run the motor 200 steps CW.

From a computer send:

E I200,R

NOTE: The "E" is sent first to get the Control ON-LINE (both yellow lights on front panel lit).

From the front panel:

Push the " | " key until the light next the INDEX is lit, press the "2" key, "0" key, "0" key, "Ent" key, "Run" key.

PROGRAMMING

COMMANDS with VARIABLES

Front Panel Menu	Front Panel & RS-232C Input	Function

First character applies only to RS-232C input

Settable (one-time entry in a program)

*	**ACCEL/DECEL**	**A**	**Acceleration** and **Deceleration.** SET RANGE: 1 to 7 or 9 to 15 **1 to 7** sets motor to **200 steps/rev** (1 being 8000 steps/sec^2, 2 being 16000 steps/sec^2, 3 being 24000 steps/sec^2, etc.) **9 to 15** sets motor to **400 steps/rev** (9 being 8000 steps/sec^2, 10 being 16000 steps/sec^2, 11 being 24000 steps/sec^2, etc.) NOTE: Acceleration and Deceleration only occurs above 236 steps/sec.

*** ACCEL/DECEL**	**A-**	**Baud rate** setting. A- value Baud rate 207 300 103 600 51 1200 25 2400 16 3600 12 4800 8 7200
*** STEPS/SEC**	**S-1**	Turns **on backlash compensation.** Whenever the motor makes a negative Index, 16 steps will be added. The motor will then reverse, moving positive 16 steps (every Index will finish approaching positive).
*** STEPS/SEC**	**S-0**	Turns **off backlash compensation.**
*** STEPS/SEC**	**S**	**Steps/sec**. RANGE: 16 to 3000 in 1 step/sec increments RANGE: 0 to 8191 (0 = 20 usec, 1 = 0.1 sec, 2 = 0.2, 10 = 1.0, 8191 = 819.1 sec = 13.65 min) If "Pause control" enabled (see U2 and U4 commands) the USER OUTPUT will go "LOW" for the duration of the Pause. When a "P0" follows an Index the motor will slow down to 236 steps/sec before moving again. If STEPS/SEC is set to 236 or less the motor will not change speed.
*** USER I/O**	**U0**	**Wait** for "LOW" on User **Input** (pin 9 of I/O).
*** USER I/O**	**U1**	**Wait** for "LOW" on User **Input,** holding User **Output "LOW"** while waiting.
*** USER I/O**	**U2**	**Disables** "Pause control" of **Output**.
*** USER I/O**	**U4**	**Enables** "Pause control" of **Output** (reset state).
*** USER I/O**	**U8**	**Output "HIGH"** (pin 11 of I/O)
*** USER I/O**	**U16**	**Output "LOW"**
*** INDEX**	**I**	**Index** steps for motor to move **Positive**. (motor rotates CW, Slider moves away from motor on UniSlides, Rotary Tables rotate CCW) RANGE: 1 to 1,048,575 steps

*** INDEX** **I-** **Index** steps for motor to move **Negative**. (motor rotates CCW, Slider moves toward motor on UniSlides, Rotary Tables rotate CW)
RANGE: 1 to 1,048,575 steps

*** INDEX** **I0** **Index** motor to **"Absolute Zero"**.
"Absolute Zero" is established when the Control is turned "on", a "Z" command, RESET, or CLEAR button is used.
NOTE: Operating the motor in the JOG/SLEW mode does not change the location of "Absolute Zero"

*** INDEX** **IM** **Move Positive** to limit switch, **Index** off limit entered value, and **zero Absolute Position** register.
RANGE: 1 to 65,535 steps
Caution: Set Speed to less than 800 Steps/Sec prior to this command to prevent damage from the sudden stop when limit switch is encountered.

*** INDEX** **IM-** **Move Negative** to limit switch, **Index** off limit entered value, and **zero Absolute Position** register.
RANGE: 1 to 65,535 steps
Caution: Set Speed to less than 800 Steps/Sec prior to this command to prevent damage from the sudden stop when limit switch is encountered.

UniSlide Lead Screw	**Adv/rev**	**Adv/step 200/rev Mode**	**400/rev Mode**	**Speed at 1000 steps/sec (200/rev Mode)**
P40,C	0.025"	0.000125"	0.0000625"	0.0125 ips
P20,B	0.050"	0.00025"	0.000125"	0.2500 ips
P10,W1	0.100"	0.0005"	0.00025"	0.5000 ips
P5,W2	0.200"	0.001"	0.0005"	1.0000 ips
WF	1.000"	0.005"	0.0025"	5.0000 ips
K1,Q1	1.00 mm	0.005 mm	0.0025 mm	5.00 mm/sec
K2,Q2	2.00 mm	0.010 mm	0.005 mm	10.00 mm/sec
K4,Q4	4.00 mm	0.020 mm	0.010 mm	20.00 mm/sec

UniSlide Rotary Table	**GEAR RATIO**	**Adv/step 200/rev Mode**	**400/rev Mode**	**Speed at 1000 steps/sec (200/rev Mode)**
B4872TS	72:1	0.025°	0.0125°	25°/sec
B4836TS	36:1	0.050°	0.025°	50°/sec
B4818TS	18:1	0.100°	0.050°	100°/sec
B79180TS	180:1	0.010°	0.005°	10°/sec
B7990TS	90:1	0.020°	0.010°	20°/sec
B7945TS	45:1	0.040°	0.020°	40°/sec

*** LOOP** **L0** **Loop continually** from the beginning.

*** LOOP** **L-0** **Sets** the **"loop-marker"** at the current location in memory. All loops (except L0) to the right will branch to here. Loops to the left branch to the beginning. The maximum number of loops a program can hold is 10 on both sides of the loop-marker (excluding L0).
NOTE: This Command can be used only once in a program.

*** LOOP** **L** **Loop** from beginning or loop-marker.
RANGE: 2 to 255 loops
Actual number of loops is one less the value entered.
Loops can be nested. The following example loops equal 100,000 (actual loops is one less or 99,999 times):

L100 L100 L10

NOTE: When any Loop reaches its last count the non-loop command directly preceding the Loop will be ignored.
To prevent a preceding Index from being ignored use one of the "U" commands or an "S" command before the Loop command.
For example, this program will index the motor positive and negative 200 steps exactly 100,000 times, the "U4" command is used as a "dummy":

I200 I-200 U4 L100 L100 L10

*** LOOP** **L-** **Loop** from beginning or loop-marker **alternating direction** of motor Indexes.
RANGE: 2 to 255 loops
Actual number of loops is one less the value entered.
Loops can be nested. The following example loops equal 100,000 (actual loops is one less or 99,999 times):

L-100 L100 L10

NOTE: When any Loop reaches its last count the non-loop command directly preceding the Loop will be ignored.
To prevent a preceding Index from being ignored use a "U" command or an "S" command before the Loop command.

IMMEDIATE COMMANDS (not stored in a program)

E **Enable** RS-232C communication. (Both yellow LEDs on front panel will light.) The Control must be in the JOG/SLEW Mode to respond to this command.

	D	**Disable** RS-232C communication. Returns to JOG/SLEW Mode. Also, the "D" is used for digitizing in the JOG/SLEW Mode.
CLEAR (button)	**C**	**Clear** program from memory. ACCEL/DECEL, Baud, and backlash compensation settings are not affected. The last STEPS/SEC value is "remembered" by the Control. The CLEAR button zeros absolute position registers, the "C" command does not.
	Keys:	
| or |	**DEL**	**Delete** current value "keyed-in".
	<-	Also the " | " and " | " are used for menu selection from the front panel.
ENT	**CR**	(Carriage Return)
	SP	(Space) **Enters** keyed in value.
	LF	(Line Feed)
	,	(Comma)
RUN	**R**	**Run** program.
	Z	**Zero** Absolute Position register.
	X	**Send** Absolute **Position** of motor. Below is what the host would receive if the motor is at negative 1200. A carriage return follows the value. **-0001200** This is what the host will receive if at positive 91203 **+0091203**
	B	**Busy** poll. Control sends "<" if busy running a program, ">" if ready. Additionally the ready prompt (">") is automatically sent to the host when a program has finished.
	H	**Hold** flag toggle. The program stops prior to every index and sends a ":" to the host. When stopped, the "X" command can be used to read motor position, an "H" will toggle the flag off, "K" terminates the program, "R" re-starts the program where it left off and a stop will again occur after the next operation. This Command allows single stepping through a program for debugging or as a program interrupt from the host.

T Character **Echo** ON/OFF **Toggle**.
Normally all characters sent to the 86MM will be echoed. Character Echo will be ON after "power-up", RESET, or a "CLEAR" by the CLEAR button. When the echo is OFF the 86MM will still send a response to the "X" and "B" commands. The "T" and the "E" (used to get the Control ON-LINE) are always echoed to the host.

K **Kill** current operation.
Interrupts running program immediately. The 86MM sends the ">" to the host.
NOTE: When a motor is running at high speed (above 700 steps/sec), command "K" interruption may cause motor overshooting, resulting in loss of position.

MEMORY/BATTERY RETENTION

The 86MM Control has 101 bytes of RAM memory for program storage. Data in the first 27 bytes of memory is retained when the Control is "OFF" by rechargeable batteries within the Control, that are charged when the Control is "ON". A loss of data retention due to low battery voltage is indicated by a flashing of the LEDs and beeping for 2 seconds after "turn-on". This may be the situation with a new Control that has not been operated long enough to fully charge the batteries. Data loss results in the following default settings: ACCEL/DECEL =1, STEPS/SEC =1000, Baud =1200, and backlash compensation "off".
From fully discharged to fully charged requires 30 hours of Control "ON" time. A full charge will be maintained if the Control is "ON" for at least 45 min/day, or 5 hrs/week. The batteries have the capacity to retain data in memory for 4 weeks of non-use.

The table below shows how many bytes of memory each command will use in a program.

Command	Bytes of memory
S	2
P	2
U0	1
U1	1
U2	1
U4	1
U8	1
U16	1
I	3
I-	3
I0	3
IM	3
IM-	3
L0	1
L	2
L-	2

All other commands use allocated memory, or are "immediate" (not stored).Each command is stored and executed in the order it is received from a host or keyed-in at the front panel. Commands cannot be added to the program if the power was turned "OFF" and "ON", which is the same as a RESET condition. When a RESET condition has occurred the ACCEL/DECEL and the Baud rate are the only changes that can be made to a program. When other commands are sent from a host the existing program will be "cleared" from memory. The Control will not accept a new program whenbusy executing an existing one.

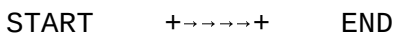
EXAMPLES

The following examples can be input manually from the front panel or sent by a host computer or terminal over the RS-232C. For entries made from the front panel, the first letter refers to the Command selected from the menu (LEDs) using the arrow keys. The space between commands is the "ENT" key on the front panel; the "R" is the "RUN" key.

EXAMPLE #1, 3 bytes RAM:
Index 200 Steps

I200 R

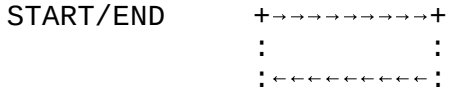
I200 INDEX 200 steps
R RUN



EXAMPLE #2, 6 bytes RAM:
Auto-Reverse

I401 I0 R

I401 INDEX 401 steps
I0 INDEX to Zero (-401 steps in this case)
R RUN

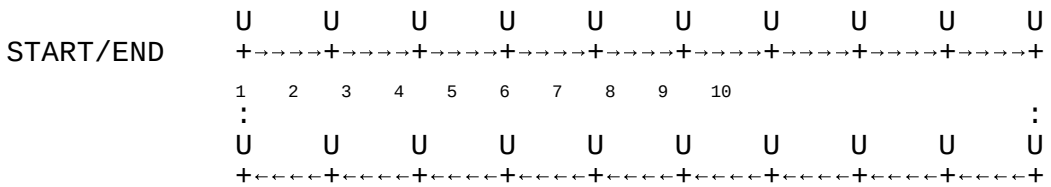


NOTE: By connecting a toggle switch to Connections 4 and 5 of I/O, the above program can provide a switch controlled continuous running auto-reverse.
The above example will dwell for 65 ms before reversing. By using a P0 command, this time will be reduced to 4.2 ms. The motor will still accelerate and decelerate at the set rate.
In this example the motor will dwell for only 4.2 ms before reversing direction: **I401 P0 I0 P0 R**

EXAMPLE #3, 9 bytes RAM:
Repeating Index two directions with wait and output

U1 I800 L10 L-2 R

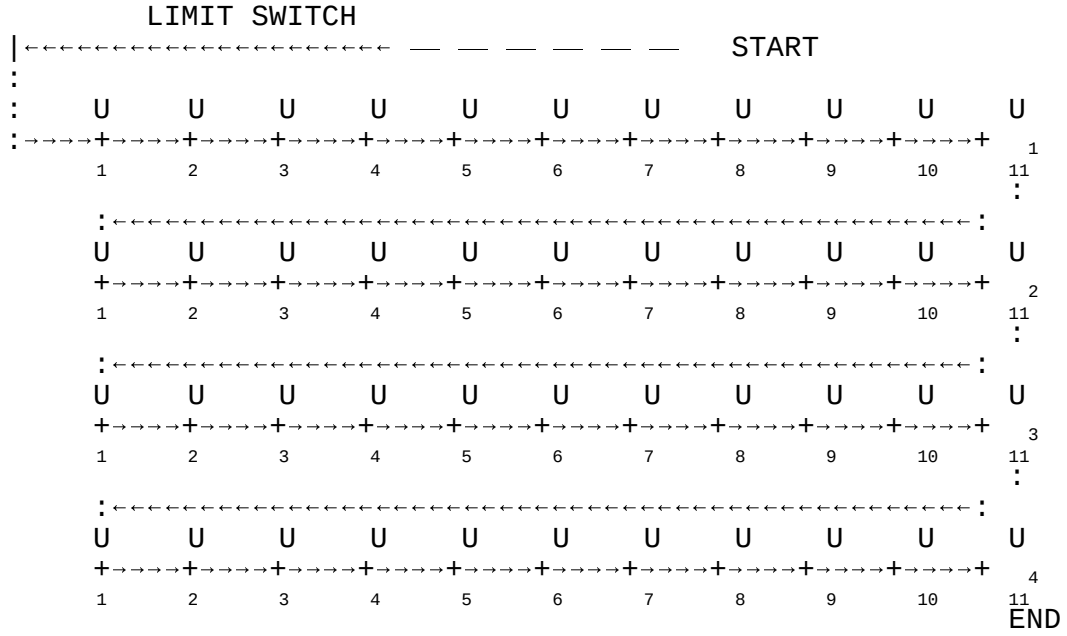
U1 Wait for LOW on User Input holding Output LOW while waiting
I800 INDEX 800 steps
L10 Do 10 times (The actual number of times the program
is repeated will be one less the Loop value, and two less
for any non-Loop command directly preceding the Loop)
L-2 LOOP from beginning with reverse direction
R RUN



EXAMPLE #4, 20 bytes RAM:
Homing and looping using loop-marker

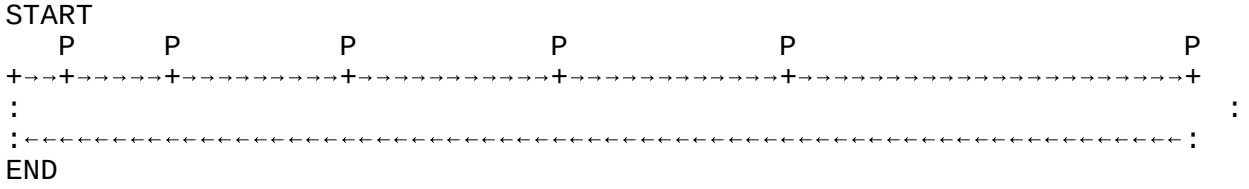
S700 IM-200 L-0 S1500 U1 I200 L11 S2000 I0 L4

S700 STEPS/SEC to 700
IM-200 Move to Negative limit, INDEX "off" 200, zero position.
L-0 Set loop-marker to here in program. Succeeding Loops will branch to this point.
S1500 STEPS/SEC to 1500
U1 Wait for LOW on User Input, Output LOW while waiting
I200 INDEX 200 steps
L11 Do 11 times (The actual number of times the program is repeated will be one less the Loop value, and two less for any non-Loop command directly preceding the Loop)
S2000 STEPS/SEC to 2000
I0 INDEX to Zero
L4 Do 4 times from loop-marker



EXAMPLE #5, 33 bytes RAM:
Several different Indexes, Pausing between each one

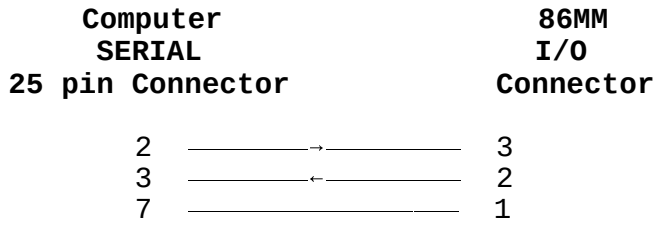
I100 P5 I250 P5 I400 P5 I550 P5 I600 P5 I1100 P5 I0



PROGRAMMING FROM BASIC ON A IBM TYPE COMPUTER

The procedure for programming the 86MM from BASIC is:

1. Make the 3 wire RS-232 connection from the host computer to the 86MM.



If a shielded cable is used, connect the shield to connection 12 on the 86MM I/O.

2. Turn ON the Control and the host computer.
   NOTE: A framing error may occur on the host's receiver when the 86MM is turned ON or reset while the host is ON. The host will display the "Device I/O error" message when the BASIC program is started. To prevent this error turn ON the host after the 86MM or only connect the RS232 cable after the host and the Control have been turned ON.

3. Boot BASIC on the computer. (PC users can also use: "Terminal" program located in Accessories in Windows 3.1 or "HyperTerminal" with Windows 95, set baud to 1200, Even parity, 7 data bits, 2 stop bits, and set flow control to None).

4. Create a BASIC program that incorporates the following:
   a. Open the RS-232 port on the computer with an OPEN COM statement.

   b. Print "EZT" to the 86MM Control to get the Control ON-LINE, Zero the Absolute Position Register and to Toggle echo off. The "Z" Zeros the Absolute Position Register, that would have accumulated steps if the motor had been run in the JOG/SLEW mode. The echo off ("T") will prevent the computer's receive buffer from filling with unwanted characters.

   c. Print the 86MM program to the Control.

   d. Wait for the ready (">") prompt, indicating the 86MM program has finished running.

   e. Perform data acquisition or control function for this motor position.

   f. If desired, request motor position from the 86MM.

   g. Print another program to the 86MM.
      NOTE: To prevent the new program from being added to the last program in the 86MM, send the Clear ("C") command prior to the new program.

The following example demonstrates a method for programming the 86MM over the RS-232 by sending commands from BASIC.

```
90 REM 86MM-1 BASIC Example Program
95 REM Open RS-232 (COM1:), 1200 Baud, control lines disabled, ASCII
100 OPEN "COM1:1200,E,7,2,CS0,DS0,ASC" AS #1
105 REM Enable, Zero position register, Toggle echo off
110 PRINT#1,"EZT"
115 REM Clear any existing program, 1000 Steps/Sec, Index 1500 steps 120 PRINT#1,"C S1000 I1500 R"
130 GOSUB 500
135 REM Clear existing program, Index 900 steps
140 PRINT#1,"C I900 R"
150 GOSUB 500
155 REM Clear existing program, Index 1000 steps
160 PRINT#1,"C I1000 R"
170 GOSUB 500
175 REM Clear existing program, 3000 Steps/Sec, Index to zero
180 PRINT#1,"C S3000 I0 R"
190 GOSUB 500
390 PRINT "DONE RUNNING 86MM CONTROL"
400 END
499 REM Wait until ready (">") prompt appears in receive buffer
500 C$=INPUT$(1,#1)
510 IF C$ <> ">" THEN 500
515 REM Request motor position from 86MM and print on your computer 520 PRINT#1,"X"
530 INPUT#1,P
540 PRINT "MOTOR POSITION="; P; "STEPS"
550 REM Your routine for end of Index would go here
600 RETURN
```

LINKING CONTROLS

Users that require more than one motor can link 86MM Controls together. Multiple Controls can be operated from a single RS232 port by linking. When linking multiple Controls together addressing is accomplished by enclosing information in brackets. Information between brackets is relayed to succeeding Controls. The number of brackets used determines the destination of the information. As each Control receives the information, it removes a set of brackets and relays the remainder of the instruction to the next Control. Up to 255 Controls can be linked together and programmed in this manner. All the yellow and green LEDs on the Control's front panel will light when in this "relay mode". For example, if four Controls are linked together and the fourth Control is to be programmed, the instruction for that Control would be placed within three brackets. The first Control receiving the information would remove one set of brackets and relay the information along, the second Control would remove the second set of brackets and the third Control would remove the third set and relay the instructions to the fourth without any brackets. The targeted fourth Control would then be programmed with the information.

Additionally, requests from the host to a specific Control for Absolute Position Register value or Ready prompt are always relayed by every Control to the host.

EXAMPLES:

This will program Control #4 to Index 800 Steps.

[[[C I800 R]]]

This polls Control #2 to see if it is busy.

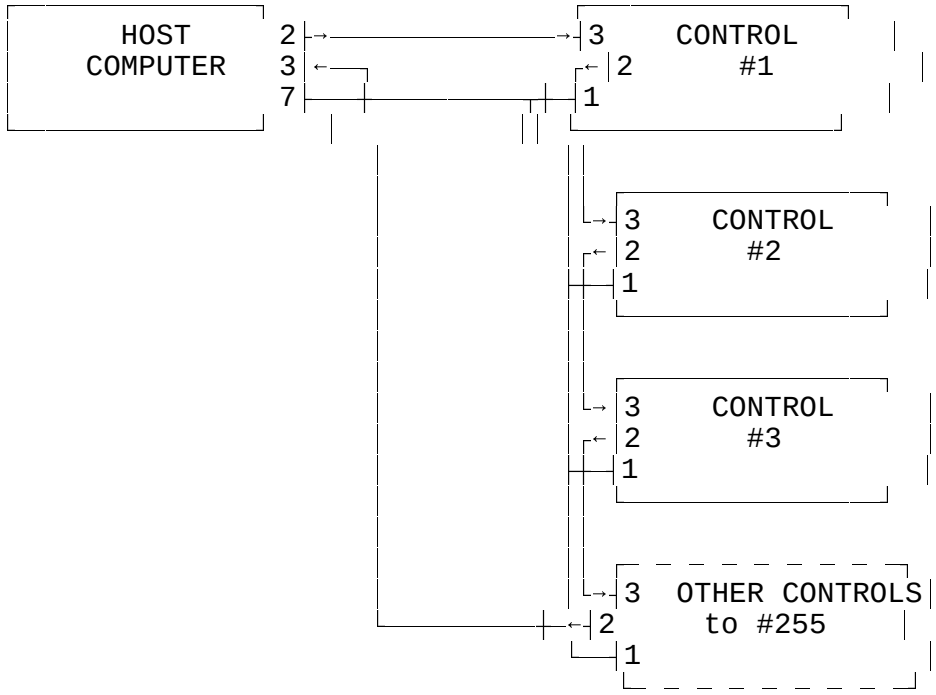
[B]

This requests motor position of Control #3.

[[X]]

The procedure for linking Controls:

1. Connect the RS-232 from the host to the 86MM Controls as shown.



2. Set RS-232 parameters on the host and Controls the same.

3. Initialize Controls by sending the following.

EZT

The "E" commands all the Controls ON-LINE. The "Z" Zeros the Absolute Position Registers that would have accumulated steps if the Controls were run in the JOG/SLEW mode. The "T" Toggle the echo off preventing unwanted replication of information to each Control.

4. Use brackets to address each Control.

TROUBLESHOOTING PROCEDURE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
JOG/SLEW light does not "light" when Control is switched "on".	Blown fuse.	Check fuse located on back of Control.
Motor does not operate.	Limit switch(es) in closed position.	Check limit switches for proper action, or try without cables attached.
Control does not come ON-LINE when sent "E".	RS-232C may not be connected properly.	Trace Transmitted Data, Received Data, and Signal Ground wires from your computer to the 86MM Control.
	Your computer or terminal is not sending upper case letters.	Transmit only upper case letters. The Control will not respond to lower case.
	Your computer may require a high on its Data Set Ready (DSR) line. The 86MM does not implement the RS-232C control lines.	Check with the computer manufacturer to see if the DSR line must be artificially pulled high, or if it can be disabled in software.
Control does not co "ON-LINE" when sent "E" or downloaded program does not operate correctly.	The RS-232C parameters not set properly.	Match the RS-232C settings on the 86MM to those of your computer or terminal.
Your computer does not receive data from the Control.	Your computer may require a "high" on its Request To Send (RTS) line.	Check with the computer manufacturer to see if the RTS line must be artificially pulled high, or if it can be disabled in software.
Motor does not run when sent commands to index.	STEPS/SEC or ACCEL/DECEL settings out of range.	Set STEPS/SEC and ACCEL/DECEL to specified values.
Motor stalls, it does not move at all.	Inertia in system too high, or mechanism has seized.	Hand operate the system to locate any binding. A larger motor, or a different ratio in the mechanism may be required.
Motor stalls, after rotating slightly.	Acceleration too high.	Use a lower ACCEL/DECEL. Use 400 step/rev mode.
	Motor cannot overcome friction or load.	Check mechanism for ease of movement. A larger motor may be required, or your load will have to be reduced or counterbalanced.

Motor stalls before reaching maximum velocity.	Motor torque de-creases as its velocity in-creases.	Reduce STEPS/SEC setting of motor.
With Motor remov-ed from equipment, Motor runs errat-ically at all speeds, has no torque.	Broken motor cable.	Check cable and connector for broken wires and repair breaks.
	Faulty Motor.	Replace Motor.
	Damaged drive transistor(s.)	Ship Control back for motor drive repair to Velmex, Inc. Repair Dept. Rt. 5 & 20 E. Bloomfield, NY 14443 or replace TIP 122 transis-tors on inside back panel.
Motor or system resonates (vibrates loudly).	The motor velocity is the motor or system's natural resonant fre-quency. This is common at speeds below 230 in the 200 step/rev mode.	Use 400 step/rev mode. Increase or decrease speed to avoid resonance points. A damper or flywheel added to the motor shaft or lead screw may dampen the resonance.
Program is lost every time Control is turned OFF (LEDs flash and buzzer beeps when Control is turned ON).	Control is not ON long enough to charge batteries.	See page 11, MEMORY/ BATTERY RETENTION for charge requirements.
	Batteries have reached their useful life (>1000 charge/discharge cycles, or 4-6 yrs).	Replace batteries. See page 19, BATTERIES for replace-ment procedures.
Control stops operating for no apparent reason.	Inductive surge on AC power-line.	Isolate or remove any equipment that may be putting "spikes" on the power-line.
	Inductive/Static surges coming in the I/O con-nections.	Make sure all external equipment connected is properly grounded and inductive loads are isolated from Control.

LIMIT SWITCHES

Limit switches are included on most UniSlide assemblies. The 86MM cable with the 7 pin Amphenol connector plugs into these limit switches. The limit switch inputs are active-low (normally high by a 1K ohm resistor connected to +5V).

The Positive limit is activated by a switch closure between pin E (Signal Gnd) and D (+ Limit). When activated, motion in the positive direction (Motor rotating CW, Slider moves away from motor) is terminated and the Control will proceed to the next command in the program.
The Negative limit is activated by a switch closure between pin B (Signal Gnd) and A (- Limit).

CABLES

Caution:
It is not recommended that the motor cable be extended or altered in any other way. If motor cable must be extended the proper wire size should be used to prevent voltage drop. For motor cables to 15 feet use #16 wire. For motor cables to 30 feet use #14 wire. For motor cables to 45 feet use #12 wire.

Motor and limit switch cables should not be put in a common conduit with other wiring.

If cables must be near inductive loads (transformers, motors, etc.) or near high energy sources, shielding of the cables may be required.

RS-232 cables should be limited to a maximum of 20 feet. However, with special EIA cable 50 feet is possible.

BATTERIES

Batteries do not require servicing, they have an estimated life of greater than 1000 charge/discharge cycles or 4 to 6 years.

To replace batteries:
1. Unplug Control from AC power.
2. Remove screws (hex nuts) at each corner of the rear panel.
3. Tilt rear panel back.
4. Pull cover rearward and up to remove.
5. Slide battery retaining clips off batteries.
6. Replace batteries following polarity markings.

Caution:
Replacement batteries should have the following characteristics:

Three 1800 mAH, High Temperature Nickel Cadmium "C" Size, 180 mA charge rating (SANYO Model No. KR-CH, or SAFT Model No. 2.0PT).
The following batteries can be substituted, but not being high- temperature type, useful life may be reduced.
Radio Shack Cat. No. 23-141, or Cat. No. 23-124.
The No. 23-124 batteries have 1100 mAH capacity, reducing program retention to 2 weeks.

SPECIFICATIONS

FUNCTIONAL

A complete microcomputer-based Controller/Driver for stepping motor control.

Interactive limit switch inputs (TTL) for CW and CCW direction.

One User Input (TTL), and one User Output (0 or +5V, 10 ma sinking capability).

Programming through full-duplex RS-232C port (300 to 7200 Baud settable, 7 Data bits, Even parity, 2 Stop bits, ASCII) or from a 16-key front panel keyboard.

User available RAM for program storage is 101 bytes, 27 bytes with battery back-up.

Motor is manually controllable at the front panel.

JOG/SLEW, ACCEL/DECEL, STEPS/SEC, PAUSE/OUTPUT, USER I/O, INDEX, and **LOOP** menu LEDs for input selection.

CLEAR, Run, M, -, | , | , Ent, and **0** to **9** buttons at the front panel.

Remote Run and Reset input (TTL) connection at the front panel.

Six foot motor and limit switch cables with connectors

MOTOR COMPATIBILITY

For use with 1.8^{o} Permanent Magnet stepper motors, 5 amp/phase max.
The 86MM Control is factory adjusted for a particular motor current.

PHYSICAL

Weight: 19.5 lbs.

Height: 8.5 inches

Width: 11.2 inches

Depth: 14.0 inches

ELECTRICAL REQUIREMENTS

120VAC 60Hz, 350 watts

ENVIRONMENTAL

32^{o} to 120^{o} F
Convection cooling